**The Most Basic Missing Instrument in Financial Markets: The Case for Forward Starting Bonds (or Creating Individual DBs)**

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ABSTRACT - Academic Version

*There is a looming retirement crisis globally with the three pillars of retirement threatened because of insufficient funding, improper investment decisions, and transferring risk to individuals who are least capable of bearing such risk. This paper argues that the introduction of a unique financial instrument, basically an inflation linked bond which pays coupons when you need it, might help ameliorate this crisis. The Life Cycle Hypothesis (LCH) demonstrated why people save; namely, they try to set aside resources during their working lives, to be able to tap into them to ensure retirement income when labor income stops. Traditional Modern Portfolio Theory (MPT) then attempted to help individuals make optimal investment decisions on these savings by investing in stocks, bonds and other assets to ensure sufficient retirement wealth. None of these assets is an ideal hedge for a desired retirement income. Further, this mismatch between focusing on retirement income in real life and retirement wealth in financial theory poses a conundrum for the average investor. More recently, researchers have been arguing that the focus for retirement investing should not be on maximizing wealth, but rather on maximizing retirement income (or funded status) – a seemingly trivial twist, but with fascinating implications. Research has shown how seemingly safe assets from an MPT perspective are risky from a retirement income perspective, and further that the Capital Asset Pricing Model (CAPM) is a very specific case of a more general Relative Asset Pricing Model (RAPM). Continuing in this vein, we make the case in this paper that capital markets are missing a very simple and basic financial instrument – that we call a Forward Starting Bond (FSB) – that can help institutional and retail investors achieve their retirement objectives at lower risk than portfolios created through a mix of traditional stocks and bonds. In essence, the need for such a bond is simple to understand: a typical saver sets aside resources today to receive a stream of income post retirement (till death) and it is the "riskless asset" in RAPM. No instrument in the market today offers such a profile and hence all attempts to recreate this profile through traditional stocks and bonds, or purchase such a profile through annuities are sub-optimal or expensive thereby threatening retirement security. The paper goes further to demonstrate that there is a potentially willing supplier of such bonds thereby completing the market. It also addresses challenges, issues and opportunities surrounding such an instrument and examines issues relating to the creation of a market for FSBs.*

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ABSTRACT - Practical Version

*The move to defined contribution plans has transfer risk to individuals who are least capable of bearing such risk and requires them to make complex decisions for which they are not prepared. The accumulation (investments) and decumulation (annuity purchase) decisions are complex, costly, often with different entities (asset managers and insurance companies), result in illiquid decisions (annuities) and may still result in highly uncertain pensions. This paper argues that the introduction of a unique financial instrument, basically an inflation linked bond which pays coupons when you need it, might help ameliorate this crisis. We call this a Forward Starting Bond (FSB) and argue that this single instrument can help investors achieve their retirement objectives at lower risk, lower cost, with greater liquidity and greater simplicity than portfolios created through a mix of traditional stocks and bonds followed by annuity purchases. The need for such a bond is simple to understand: a typical saver sets aside resources today to receive a stream of income post retirement (till death) and the FSB is the "riskless asset" as it bridges the time gap between accumulation and decumulation. The paper goes further to demonstrate that there are potentially willing suppliers of such bonds thereby completing the market. It also addresses challenges, issues and opportunities surrounding such an instrument and examines issues relating to the creation of a market for FSBs.*

**The Most Basic Missing Instrument in Financial Markets: The Case for Forward Starting Bonds**

Background – The Looming Retirement Crisis and The Investment Challenge

There is a looming global retirement crisis as the three pillars of retirement security - State-provided Social Security, Employer-provided defined benefits (DBs) or defined contributions (DCs) and Private defined contribution savings – are teetering on the brink of trouble for a host of reasons. The first two systems are typically underfunded – i.e., the accumulation, if any, is insufficient for the retirement promises made. In the case of Social Security, these DB schemes were (largely) funded through a Pay-As-You-Go (PAYG) mechanism, whereby the young are taxed to pay off the old. As Modigliani and Muralidhar (2004) demonstrated, this method of funding Social Security puts the scheme in jeopardy as PAYG is highly dependent on changes to demographics or productivity. These factors have negatively impacted Social Security systems globally and will continue to do so for the foreseeable future. They recommend converting these systems to partially funded systems, but that still leaves the questions of (a) how much taxes need to be raised; and (b) how the accumulation should be invested to minimize the risk to governments and future generations.

Employer-based DB plans have also suffered badly, especially with the bursting of the technology bubble in 2000-2, and the Great Financial Crisis (GFC) in 2008. The average funded status – or assets divided by liabilities –of these plans, in most countries is now below 100 percent (Muralidhar 2015) and the likelihood of improvement is low because the sponsors cannot contribute to their pensions and expectations of asset returns are weak. In some part, this situation in the DB plans was caused by poor investment approaches that did not try to match assets to liabilities (e.g., the poor application of

Modern Portfolio Theory or MPT), and in some part to missing instruments to manage this risk. At least with DB plans, there is an inter- and intra-generational sharing of risks along with a backstop through a sponsor, so asset-liability mismatches and low funded status do not affect the current generation entirely, but it does affect future generations and the sponsor who may have to bear an undue burden.

Increasingly, companies and government entities are no longer providing DB plans and are transferring the entire retirement risk to the individual via DC plans or to private savings (which have the same risk profile as a DC plan). In addition to the problem of insufficient coverage of individuals (Muralidhar 2015) – i.e., people either not being offered a plan or being offered one and not participating – the bigger issue is what assets must the individual investor allocate to in order to achieve his/her retirement goals. Since the individual investor has just a single lifetime over which to execute these decisions and manage this risk between desired retirement income and accumulation, we will focus entirely on the individual as it is the most interesting problem. The extension to institutional investors managing DB plans is trivial and we will cover that in passing and in the Appendix. In effect, the financial instrument we are advocating for potentially allows individuals to create their own defined benefits – something currently unavailable at the individual level because traditional DBs have been based on the notion of inter- and intra-generational risk sharing and the existence of a sponsor (either government or employer).

In this paper, we will argue that there is a key instrument that is missing in financial markets – a Forward Starting Bond (FSB) – and unless this instrument is created and issued by governments (at a minimum), retirement security will be jeopardized. This is a simple instrument to create and it achieves the goals of the average investor thereby (a) simplifying the investment decision (eliminating complex investment approaches); (b) reducing the risk of achieving a target retirement income; (c) lowering the complexity

and costs of investing assets (as it removes the need for intermediaries); (d) ensuring that both the accumulation and decumulation can take place under the same entity (much like a DB); and enjoying complete liquidity (removing the illiquidity problem of annuities). In order to make the case for this instrument, in Section 1, we examine the theoretical literature behind savings and investment and demonstrate how some of the theories, including Nobel Prize winning theories, may have missed a key facet of investing, and how the poor application of these theories in portfolios jeopardized retirement security globally. In short, theories that focused on maximizing wealth, by ignoring the uses of these funds, when used by investors who are focused on maximizing retirement income, may have led investors to wrong investment decisions. We show how the current range of assets, investment approaches or even regulator approved products are woefully inadequate and will lead to bad outcomes for high fees for the typical investor. As a result, in Section 2, we are able to demonstrate why a FSB would be a very valuable instrument as it provides a much needed bridge between the uses of funds and the asset markets. Having established that there would be demand for such an instrument from institutional and retail investors globally, in Section 3, we examine who would be the most appropriate entity to issue such a bond. Section 4 examines the challenges underlying such a bond – at a minimum, pricing, spanning the curve, and credit risk – and how some of these challenges can be overcome/mitigated. Section 5 explores areas for future research, including how institutional DB funds and insurance companies will benefit from such an instrument, and Section 6 concludes.

Section 1 – Theoretical Background and Failings of Current Investments and Approaches

For simplicity, in this paper we will focus strictly on the decisions of the individual and examine implications for institutions in the Appendix.[2] We will also assume that all decisions are made in real terms and ignore any tax implications of retirement saving as it simplifies the exposition. At the heart of it, the basic decisions that an individual needs to make to ensure a safe and comfortable retirement in a DC plan are (a) how much to save; and (b) what assets to invest the savings in. This greatly complicates the decision-making for an individual in dynamic markets, as we will demonstrate shortly, because given the available instruments, it is not easy to achieve a safe retirement without taking a fair amount of market risk, engaging in complex financial transactions, incurring substantial costs (because of intermediaries who profess to offer to help individuals achieve this goal) or being forced into illiquid options (e.g., annuities). Therefore, for unsophisticated investors at a minimum, there is a need to introduce new instruments that greatly simplify the investment decision so that the duality of the problem is reduced to just a single problem: how much to save. Implicit in this comment is also the acknowledgement that today investors save with one entity (brokerage, 401K vendor) and decumulate with another (insurance companies) and this instrument can ensure that the participant engages with just one entity (or rather one instrument).[3] This section examines the theoretical literature behind savings and investment (much of it Nobel Prize winning contributions), and demonstrates how some of the theories may have missed a key facet of investing, and potentially how the poor application of these theories in portfolios jeopardized retirement security. In short, theories that assumed that investors maximized wealth for wealth's sake, by ignoring the uses of these funds, may have led to recommendations that were implemented by practitioners without acknowledging the importance of

[2] The challenge for institutional investors that pool the risks of many individuals (i.e., inter- and intra-generational pooling) is a lot simpler than that of a single individual, who has to manage the risk over just one lifetime.

[3] I would like to thank Prof. Robert Merton for highlighting the importance/challenge of having multiple entities manage one's retirement savings and decumulation.

this nuance, and in turn led investors to wrong investment decisions. We show how the current range of investment approaches or even regulator approved products are woefully inadequate, especially for the individual investor, and will lead to bad outcomes for high fees for the typical investor unless there is some innovation.

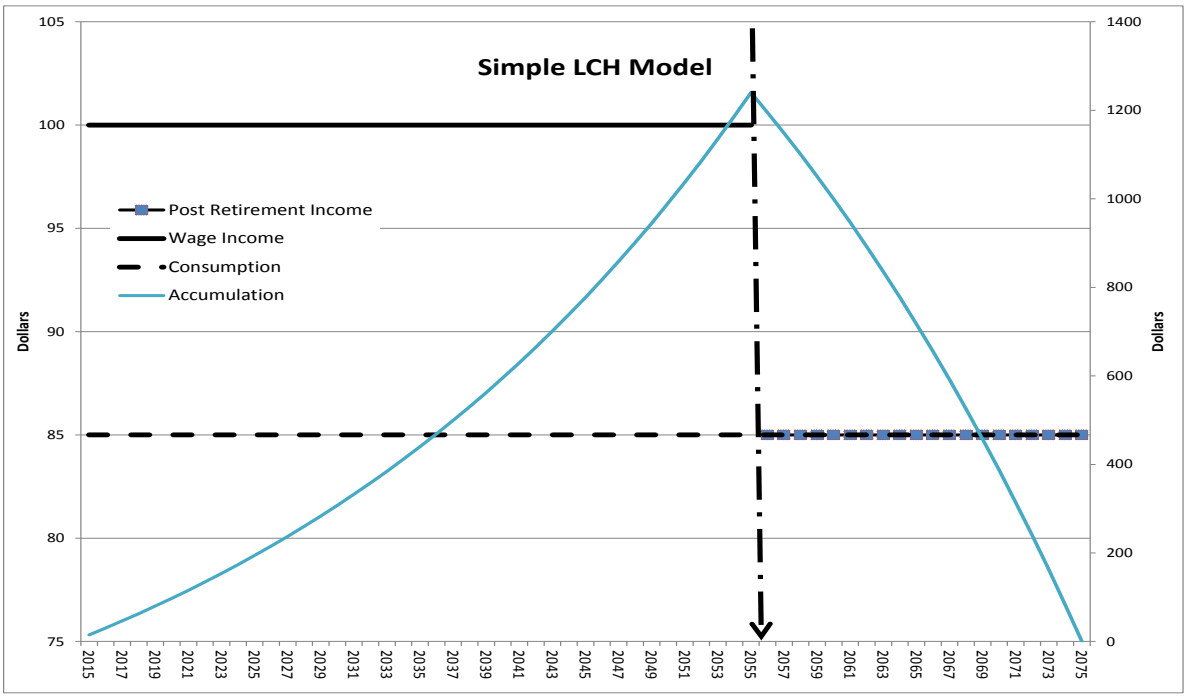
### a. Why Hold Assets: The Life Cycle Hypothesis

The most fundamental question is: why does an individual or an institution hold a portfolio of assets? Modigliani and Ando (1963) demonstrate through a very simple model, that given the Life-Cycle Hypothesis (LCH), individuals accumulate resources during working life to be able to finance consumption in their non-working life or retirement. In effect, the goal of the individual is to create a stream of retirement income to be able to finance retirement consumption. In practical parlance, the desired retired income stream is referred to as the "liability" or "L". The fact that some part of current income is saved for future consumption/income creates an asset pool on which investment decisions have to be made to ensure that they are adequate for the retirement phase.

Figure 1 demonstrates a very simple LCH model with no uncertainty. The investor is assumed to earn $100/year for 40 years and then retires in year 2055 with retirement extending 20 years and she dies in 2075; she consumes $85/year for 60 years until death. The dashed arrow highlights when retirement takes place, and the blue line rising up from zero, and growing at a particular rate of return is the accumulation (or assets) measured on the right hand side axis. Looking at the liability in isolation, it exists even before the individual starts to earn income and is essentially nothing more than the line highlighted with solid blocks in Figure 1 - zero till 2055, and then $85 every year from 2055 – 2075 (or till death). In order to generate this retirement income stream, for this level of lifetime income and savings, and assuming no bequeathing and no discounting for simplicity, the portfolio must earn a return of

3.21%. The hump-shaped solid line measured on the right axis captures the accumulation of the monthly savings that is growing at this rate. This rate of return was established by asking the simple question: given a desired post retirement income stream (referred to as an "annuity"), and a given savings pattern pre-retirement, what rate of return ensures the right amount of target wealth?

**Figure 1. LCH – Accumulating Assets to Finance Retirement Consumption.**




In such a simple approach, the next step would be to ask, what portfolio ensures such a rate of return over the life of the individual? Reality is more complex as these parameters (e.g., income, consumption, taxes, post retirement-consumption) are not known with certainty, but the purpose of this example was to highlight that the driving force behind the optimal savings decision is the desired post-retirement consumption/income or liability. Traditional finance then focuses on securing the highest risk-adjusted return for a target risk level or maximizing wealth for a given risk level and appears to ignore the liability which has led to a blind spot in traditional finance theory. This nuance of ignoring the liability will be discussed in more detail below as it is a critical point and demonstrates how traditional finance theory, by missing the importance of the liability, offers recommendations for portfolio structuring that, when adopted by professional managers of retirement portfolios (who ignored this oversight) may have led in some part to the retirement crisis.

We briefly discuss the basic investment instruments available to an individual and institutional investor as a pre-cursor to discussing the traditional finance models. Our goal is to highlight the fact the current range of instruments do not provide the desired profile for investors at low cost, high liquidity, minimal complexity, or with low credit risk.

### b. Current Investment Instruments (and where Savings are Parked)

Today, the typical investor has to choose among the following assets: stocks, bonds, commodities, alternatives, and annuities. We briefly describe each instrument, their cash flow profile, costs and liquidity, and their place in retirement portfolios (based on current practice and their ability to hedge the liability from LCH). We also briefly discuss real estate (i.e., home purchases) as many individuals hold a substantial portion of their net worth in their house.

Stocks: Stocks are an ownership claim in a company and hence provide no guarantee of either the return of principal or any future cash flows. Where such cash flows are offered, they are called dividends, but these are highly variable and are entirely at the discretion of the management. These stocks or stock indices can be acquired at low cost and are typically very liquid. While these instruments have very unpredictable cash flows and would not typically be a good hedge against the liability described above, many have argued for the inclusion of stocks in retirement portfolios because of their growth potential and potentially long duration (Dechow, Sloan and Soliman 2002).[4] Just about every financial planner advocates for including stocks in retirement portfolios because their expected return typically exceeds that of bonds, and their risk can be mitigated through diversification (Markowitz 1952).

Bonds: Coupon bonds are a form of lending where the investor lends a fixed amount to the issuer (principal), and then based on the coupon, receives a fixed cash flow at regular intervals, with repayment of the principal at maturity. “Default-free” government bonds are typically issued with

[4] Leibowitz et al (1989) would dismiss the use of duration for equities.

maturities from 3 month (referred to as T-Bills in the US) all the way up to 30 years in most developed markets and in the U.S., they are issued with standard maturities – 2 years, 5 years, 10 years and 30 years. The current maximum duration achievable in the US market through holding a 30 year security is approximately 15 years. For countries with sufficient debt and regular debt issuance profiles, as these instruments age, they provide investors with bonds that mature all along the 30 year spectrum. In most markets, nominal bonds dominate the bond markets though in some countries there are well developed inflation-linked instruments.[56] These instruments are traded at low cost, are typically liquid, and lend themselves to derivative instruments that alter this basic profile. These include zero-coupon bonds (where the investor receives no cash flows between the investment date and maturity, but in normal market environments, the principal received at maturity is a higher amount than the amount lent at initiation of the contract) and swaps (where two investors exchange fixed cash flows for variable cash flows over the term of the contract). Bonds engender credit risk (i.e., the risk that the borrower may go bankrupt and not return the principal), though the bonds of governments issued in their own currency are usually considered default free. Their key limitation for the purpose of this paper is that they have limited maturity (as noted above) relative to the Liability in Figure 1 and have a cash flow timing mismatch, especially for young investors. For example, Bodie (2001) discusses the use of inflation-linked bonds to hedge a minimum standard of living after retirement (along with other tools), but this hedging will involve risk if the yield curve does not extend to entire working and retirement profile. What this implies is that to recreate the cash flow profile in Figure 1 would require a fair amount of complex financial engineering (e.g., Merton 2014).

[5] Bodie, Merton and Samuelson (1992) have argued for standard-of-living indexed bonds as a way cost-of-living risk as the typical inflation-linked instruments do not provide an adequate hedge against say medical inflation risk.
[6] Theo Kocken notes that in countries like the Netherlands there is no incentive to issue inflation-linked bonds because these bonds do not help with compliance with European measures of deficits etc.

If the typical yield curve of bonds does not extend beyond 30 years, then for a 25 year old seeking to save for retirement 40 years out and that too for the subsequent 15-20 year period of their retirement, there is re-investment risk of both the coupon payments and the principal amount. Further, nominal bonds engendger inflation risk (i.e., the risk that the nominal payments over the term of the contract will get eroded by inflation). Despite this mismatch between the desired liability profile of individuals and this asset, bonds (and its derivatives) typically form a substantial portion of individual and institutional retirement portfolios. This is driven in some part by traditional investment theory described below that treats this instrument as the safe asset. Further, this instrument is used in hedging the risk in mature DB plans (see Appendix), where the duration of the institutional liability is typically in the range of 15 yrs and hence hedged reasonably well by a 30 year bond contract or an optimized portfolio of bonds along the maturity spectrum.

Commodities: These instruments typically mimic the price of the underlying commodity and are believed to be a hedge against inflation risk (Froot 1995), which then leads to their inclusion in institutional retirement portfolios. Like stocks, the capital is entirely at risk and unlike stocks and bonds, these investments do not have periodic cash flows. They are accessed at low cost and are very liquid, but are not a good hedge against individual liabilities (except where investors seek to hedge consumption risk that may be tied to commodity consumption in retirement).

Alternative Assets: Many institutional investors have recently invested heavily in hedge funds, real estate and private equity investments. With the exception of certain real estate investments, these investments typically do not have predictable cash flows either during the life of the investments or at "maturity". As a result, these investments are not a good hedge for the individual liability described above. They typically are high-cost and illiquid investments. Their appeal in the institutional world stems from the perceived higher return offered for bearing illiquidity risk (and potentially more relaxed investment constraints). More critically, given that most institutional pension funds are underfunded, the belief that they offer a higher expected (not necessarily achieved) return than traditional stocks or bonds, leads to their inclusion in institutional portfolios as a way to juice up the overall return of their portfolio. There are also some claims that since these assets have a poor correlation to other assets they offer diversification benefits, but some part of the lack of correlation is driven by the fact that these investments are opaque and not marked-to-market daily and lack a transparent price until liquidation.

Annuities: Since none of the basic instruments described above offer the desired cash flow stream to hedge individual liabilities, insurance companies have stepped in and offer annuities to investors. At its most basic level, an annuity offers an individual, for a specific (upfront) payment, a cash flow stream from the insurance company, starting at some future date (say retirement), typically till death. There are many annuity products but one can categorize them based on: (a) timing (i.e., either immediate or deferred); (b) investment type (i.e., fixed or variable, which influences what assets the portfolio is invested in); and (c) liquidity (i.e., with or without withdrawal penalties). These instruments are complex, as the pricing is not transparent (especially because of the mortality risk calculations), and these characteristics put them beyond the comprehension of the basic investor. For example, in examining why so few Americans buy annuities, Brown et al (2012) report that many are deterred by the complexity of the choice and few people have any experience with these instruments during their working lives, making annuities an alien instrument. Further, they are typically much more expensive than market-based financial instruments, are illiquid or expensive to exit, and engender credit risk (even though insurance companies are regulated for solvency). These instruments are not very common in individual portfolios, and are only now being included in institutional DC plans (Denmark 2014). They are relatively non-existent in institutional DB portfolios, with some exceptions, even though they offer a seemingly ideal cash flow profile for retirement planning. [7] There is also some concern that seniors have been taken advantage of disproportionately by mis-selling of annuities.[8] Finally, given the costs associated with these instruments, some (Russell 2015) have advocated for the creation of non-profit annuity providers, specifically for the state plans that are being designed to cater to uncovered workers (who tend to be at the lower end of the income spectrum).

The risk for the insurance company, in offering these instruments, is that they need to diversify their risks (e.g., either cash flow or longevity) through signing up a large diverse population, and also in engaging in liability hedging financial decisions much like that of an institutional DB plan described in the Appendix. However, unlike the DB plan which is back-stopped by a corporate or governmental entity, an

[7] More recently, some have argued for the creation of Tontines – a unique financial product based on payouts to survivors. See for example Forman and Sabin (2015). Since these are not part of either institutional or retail portfolios we do not address them here, but they seek to achieve a similar goal of hedging retirement income and longevity risk.

[8] Consumer Action, a consumer advocacy group, note that people 60 and older make up 15 percent of the U.S.population, but they account for about 30 percent of fraud victims (http://www.nasaa.org/1950/senior-investor-alert-free-meal-seminars/)

insurance company has to support these annuity claims with its own capital (or hedge some risk through re-insurance companies, which then raises the cost and transfers the risk to the re-insurance company). In a way, creating the FSB will greatly alleviate many of the problems currently associated with annuities as it is a simpler and more direct way to access the desired cash flow profile.

House/Reverse Mortgages: While not normally considered in typical theoretical models of investments, an individual's house is typically one of their biggest asset holdings and where savings are often diverted during working life. However, given that one's house (distinguished from real estate investments in portfolios like REITs) is an illiquid investment and does not generate positive cash flows (but instead requires negative cash flows), many are recommending the use of reverse mortgages to finance retirement income (Merton 2014, 2016). Very simply, a reverse mortgage is where the individual turns over the ownership stake in their house to a company at death. In return, they continue to stay in the house, but receive a stream of income – much like an annuity - till death from the counterparty to the transaction. Depending on survivor clauses etc., at death, the ownership of the house is turned over to the counterparty. Much like annuities, the problem with reverse mortgages is that they are opaque and embed some credit risk for the investor (i.e., that the counterparty goes bankrupt) and longevity risk for the counterparty (i.e., the risk that the individual outlives their life expectancy). Since there is no transparent pricing curve, evaluating these instruments is hard and there have been claims that these instruments can be used to defraud individuals.[9] In some instances, reverse mortgages pay out lump sum payments as opposed to annuities and if the investors spend this windfall, then they are at risk of not receiving the income stream they require through retirement. Once again, the existence of our FSB might help make this transaction transparent as we show in Section 5 below.

In summary, none of the public assets provide a hedge against retirement income, and even annuities, which attempt to do so, are problematic and as a result, rarely found in retirement portfolios. Finally, housing, which may be a major store of asset value is illiquid and difficult to convert into the desired retirement income stream. This lays the first piece of the foundation in the case for FSBs; namely, creating a simple, liquid, publicly traded, low cost hedge for retirement income, which effectively embeds the returns during working life and the annuity payout at retirement.

### c. How To Invest Assets: Modern Portfolio Theory (MPT) – Theory and Practical Challenges

[9] Silver-Greenberg (2012).

MPT, which comprises Harry Markowitz's mean-variance optimization (MVO) and the Sharpe-Linter-Tobin-Mossin capital asset pricing model (CAPM), is the backbone of modern finance; see Lintner (1965), Markowitz (1952), Mossin (1966), Sharpe (1964), and Tobin (1958). *MPT assumes that the goal of the investor is to maximize wealth over a given investment horizon*. Retail and institutional investors globally use MPT to structure portfolios because it is simple and elegant and that is what they are taught in typical classes for either MBA or CFA programs. MVO demonstrates how an investor can achieve the highest return per target level of risk (or lowest risk for a given target return), given expected returns, volatilities and correlations, by holding a diversified portfolio of assets, and is the mainstay of investment practice. In our LCH example, an investor would make assumptions about expected returns, volatilities and correlations and try to generate 3.21% real annualized over the investment horizon for the lowest possible risk – the output of the model being the Strategic Asset Allocation (SAA) of the investor with target allocation levels to each asset. The one practical shortcoming of this approach is that our ability to forecast these variables is very poor and as Muralidhar (2015b) shows that, even if we could forecast these variables perfectly, given volatility and dynamic markets, our confidence that actual asset returns converge to the forecasted level is high only for time horizons close to 30 – 40 years. In other words, even with a Nobel Prize winning MVO approach, given the assumptions of the model, investors may not know for 30-40 years whether they made decisions on true knowledge of asset returns or on noise!

CAPM assumes that investors derive utility from wealth and are averse to volatility, and it utilizes a relatively simple equilibrium model that provides robust recommendations for asset pricing and asset allocation. To quote Markowitz (2005), in its purest interpretation, all investors, whether retired widower or young investor, will allocate their assets between the risk-free asset and the market portfolio, with differences between individuals or institutions differing only in their desire for/aversion to volatility (called Two Fund Separation as shown in Tobin (1958)). The risk-free asset in MPT is assumed to be an instrument with zero volatility and zero correlation to other assets and since such an extreme asset does exist, in practice it is proxied by either a T-bill or a T-bond. Black (1972) acknowledges this fact and derives a version of CAPM where the risky asset is more like a T-Bill or T-Bond, or an instrument with volatility, but is again focused on wealth maximization. The theoretical market portfolio is the value-weighted portfolio of all assets in the market, typically proxied in practice and often, even in empirical tests, by an equity index (e.g., the S&P 500 Equity Index), even though

CAPM does not limit itself to equity assets in the market portfolio. Most investors do not appear to implement Two-Fund Separation, but they do use CAPM inputs on returns to structure portfolios using MVO. What is interesting is that many of them use MPT to derive optimal portfolios while having an objective function different from that postulated in the theory. Probably the most common example of this use of MVO for individual savings is in offerings of robo-advisors.

We now turn our attention to how MPT, by focusing on maximizing wealth (for a given level of risk), as opposed to maximizing retirement income (for a given level of risk) for traditional individual savers, may have led investors to use incorrect models of asset pricing, asset allocation and even missed opportunities for financial innovation. This misuse of theoretical models leads to a lot of challenges for retail investors. To be clear, in the institutional world, many researchers have noted the need for liability-based asset allocation (as we note in the Appendix and below), but few have focused on the implications of this approach for asset pricing or for financial products.

### d. "Failing" of MPT, How Institutional Investors Manage to Liabilities and the Challenge for Retail Investors

Rather than hold assets to earn the highest risk-adjusted return as was the assumption in Markowitz (1952) or Sharpe (1964), retirement assets are actually held to service some future liability and herein lies the first twist in the use of MPT to manage retirement portfolios. This aspect of investing to service a future liability was recognized by Merton (1973), focusing on just the decision of a representative individual, and also in Sharpe and Tint (1990), focusing on the liabilities of a pension fund[10]. Inspite of this recognition of the importance in liabilities in asset allocation decisions, an approach termed Liability-Driven Investing (LDI), making the liability the reference point to derive asset pricing models was only addressed in Muralidhar, Ohashi, and Shin (2014) – in a model they called the Relative Asset Pricing Model (RAPM) - and it has interesting implications.[11] First, RAPM demonstrates how the CAPM

[10] In the Appendix, we provide a more extensive list of references of researchers who highlighted the asset allocation implications of an LDI approach.

[11] Some would argue that Solnik (1974), which allows for a different currency numeraire to the standard CAPM, is a precursor to RAPM and provides the theoretical basis for RAPM. This is a fair point – the true contribution of Muralidhar, Ohashi and Shin (2014) is not in the model (as they use a modified version of Reisman-Lauterbach (2002)), but rather in the recognition of the variable and its characteristics in actual investment decisions. Moreover, the even more interesting contribution of Muralidhar, Ohashi and Shin (2014) is probably the demonstration that the Behavioral Finance critique – that MPT lacks a reference point – is validated and reconciled

asset pricing is a very specific case of a much more general model, and can only be correct if the Liabilities are deterministic – this is clearly not true in real life, in turn negating the use of CAPM for basic retirement investment decisions. Second, Muralidhar, Ohashi and Shin (2014) also try to show how the focus on Liabilities in RAPM may help resolve the Behavioral Finance critique and some of the factor-based critiques of MPT. Third, with respect to asset allocation, the RAPM approach, much like the simple single-period CAPM model, demonstrates that investors should engage in Three Fund Separation; namely, hold a Liability Hedging Portfolio, a Cash Portfolio and a "Market" or Return Seeking Portfolio. Interestingly, this type of portfolio structuring is common among institutional DB investors who are governed by strict solvency regulations (e.g., Dutch pension funds, US corporate pension funds) and in the Appendix we demonstrate how mature DB pension funds are able to do so because they are able to hold a duration-matched liability hedging portfolio. However, this same approach cannot be adopted by an individual investor (say a 25 year old) or even an institutional DB portfolio with a duration much higher than the current 30 year bond. Their liability hedging portfolio cannot be created by even the most complex financial engineering of market instruments or will be expensive to purchase if solicited via an annuity or a swap with a market-based counterparty. Hence the need for our FSB.

The key point, as Merton (2014) argues, is that the goal of retirement investors should not be to maximize wealth, but rather maximize funded status, as this effectively puts the spotlight back on retirement income as the goal of investment decisions. Merton (2014)'s goal was to show how assets regarded as safe in the traditional MPT context – T-Bills – are actually risky from a RAPM context (or when measured from the perspective of annuity income units). This is shown in Figure 2 as the relative volatility of a T-bill (relative to desired annuity) is clearly non-trivial and non-zero or low. Moreover, he demonstrates that investment approaches adopted by many DC funds and retail investors, especially Target Date Funds (TDFs), are actually bad and risky approaches from a retirement income perspective.[12]

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with an MPT approach. They go further to try to show how MPT might be reconciled to the Factor approaches and this will be addressed in future research – Savickas and Muralidhar (2016).

[12] Target Date Funds are portfolios of stocks and bonds, where the allocation to bonds increase as the investor ages. They are normally referred to by a retirement date (e.g., 2050), and have a starting allocation to stocks and bonds and then a glide path, which adjusts this allocation based on the calendar year.

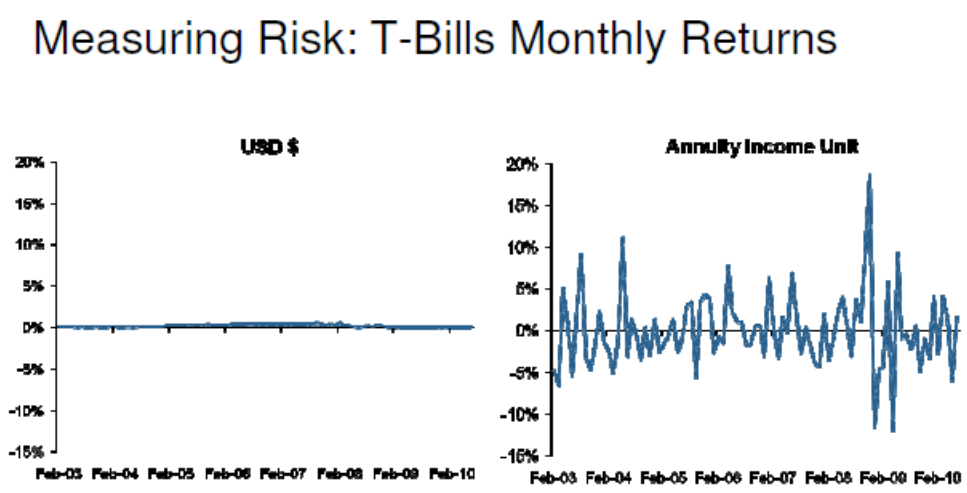



**Figure 2: Measuring Risk of T-Bills from an Absolute and Relative Volatility Perspective** (Source Merton: 2014)

Muralidhar (2011) has a similar and more extensive critique of TDFs, especially since the US regulators provide safe-harbor protection to DC pension plan sponsors if they offer TDFs to their staff. In effect, TDFs offer no surety of any retirement outcome and only guarantee that the asset allocation will change with time – and for this measly assurance, investors pay a reasonably high fee. Merton (2014) argues for DC funds to adopt a dynamic approach that allocates to various assets to ensure some basic level of retirement income (i.e., avoiding the purchase of deferred annuities, and instead investing not only in the hedging portfolio, but also in equities early in life to grow the asset pool). But there is a lot of risk in this strategy because the basic hedging instrument, our FSB, does not exist in markets.

One other twist noted by Prof. Merton (in private correspondence) is that the attractive feature of a DB fund is that the accumulation and decumulation is made within the same entity, with little to no input from the participant. This is not the case in typical DC plans and this poses a significant challenge to the typical participant (and particularly so for those who are less sophisticated). However, more recently, some vendors are trying to offer in-plan deferred annuities, but these products have surrender fees if

the participant wishes to liquidate their annuity position.[13] We will show how the FSB embeds this attractive quality in a single instrument as opposed to being dependent on the entity.

### e. Collective DC as a way of Hedging Retirement Income Risk

An alternative approach being considered in countries like the Netherlands and even in the USA is a pension system called Collective DC. The idea behind such a structure is that while increasingly pension systems are being converted to DC, there may be a way for individuals to still capture the benefit of pooling by working collectively to ensure an inter- and intra-generational pooling of risk. In a way, these structures are trying to overcome the challenge of having to deal with multiple entities to ensure effective retirement. But these structures also create inter- and intra- generational equity issues. Typically, the future generations are at a disadvantage as they are not participants in the decisions on the subsidy provided to the current working or retirement generation, and hence have to bear the cost of decisions made by the current generation. In effect, this is an attempt to create DB-like profiles within a DC structure, but it starts to fall apart because of the mismatch in goals across generations and generational inclination to share surpluses with the current generation and transfer deficits to a future generation. In a way, the FSB replaces inter-generational risk sharing with inter-generational solidarity.

### f. How a Guaranteed Return Makes a DC into a DB

Modigliani and Muralidhar (2004) showed analytically, how for a given target replacement rate (i.e., ratio of retirement income to earnings in working life), under certain conditions, a guaranteed return on all contributions (fixed as a percentage of income), would ensure this result. Modigliani and Muralidhar (2004) developed this approach in an attempt to simplify the typical Social Security DB formula and to show that a DB plan was nothing more than a DC plan with a guaranteed rate of return. However, in Social Security (and employer) DB systems, there is a sponsor who bears residual risk and can potentially smooth investment outcomes over multiple generations (or change contributions and benefits). Some have mistakenly argued for such a guaranteed return model for all DC plans (Ghilarducci 2009), believing

[13] http://www.plansponsor.com/The-Principal-Launches-Guaranteed-Income-Option-for-Plan-Participants/?fullstory=true

that such guarantees achieved via market participants, and some states in the United States have embedded a guaranteed return as a requirement for their plans for uncovered workers.[14] In individual retail arrangements, as we will show, an FSB can play a similar role, guaranteeing a return over working life, thereby guaranteeing a payment of a fixed level of income. If this is true, then given the guaranteed average return, the investor's problem is reduced solely to how much to contribute.

In summary, the absence of a basic financial instrument – our FSB - in some part because of our blinder-like focus on retirement wealth and not retirement income, forces investors to engage in complex and costly portfolio decisions themselves (or having to delegate to agents at high cost), often with multiple entities, which in turn does not ensure retirement safety and would require extensive regulation to ensure that the vendor/s is/are truly able to provide the retirement income stream their many clients desire.

## Section 3: The Forward Starting Bond (FSB)

Having demonstrated that the current range of assets and investment approaches are typically expensive, illiquid, complex, involve multiple entities or leave the individual investor with a reasonable risk of not achieving their liability, we now make the case for the FSB. Again, in the interests of simplicity, we will assume that there is no longevity and timing risk (i.e., the retirement date and life expectancy post retirement is known), salary growth (i.e., the real income is unchanged), or even inflation risk. These issues are important and we will address it in future research in the context of the optimal savings decision given the existence of an FSB. For now, we just want to lay out the basic case for the FSB.

[14] See for example the Public Act for Connecticut (http://www.osc.ct.gov/crsb/statutorylanguage.html). In addition to requiring no liability for the state, they require low costs, options for participants with low sophistication, a guaranteed return and the provision of an annuity (with survivor benefits). The FSB is ideally suited for these requirements.

### a. The Basic Design

In effect, the FSBs will be a series of real bonds issued at different forward starting dates (e.g., 5 years, 10 years, 15 years, 20 years, 30 years, 35 years), each with a term of 15-20 years. The term of the bond will be linked to the life expectancy in the economy post retirement, and can be updated periodically. For example, in Table 1, we provide the post-retirement life expectancy used by Social Security in the US.[15] This Table would argue for a 20 year maturity and we will address how those who expect to outlive 20 years would manage that risk.

| Table 1: Life Expectancy for Social Security | | | | |
|---|---|---|---|---|
| Year Cohort Turned 65 | Percentage of Population Surviving from Age 21 to Age 65 | | Average Remaining Life Expectancy for Those Surviving to Age 65 | |
| | Male | Female | Male | Female |
| 1940 | 53.9 | 60.6 | 12.7 | 14.7 |
| 1950 | 56.2 | 65.5 | 13.1 | 16.2 |
| 1960 | 60.1 | 71.3 | 13.2 | 17.4 |
| 1970 | 63.7 | 76.9 | 13.8 | 18.6 |
| 1980 | 67.8 | 80.9 | 14.6 | 19.1 |
| 1990 | 72.3 | 83.6 | 15.3 | 19.6 |

**Table 1: Life Expectancy Table from Social Security (Source: www.ssa.gov)**

There are two possible versions of this instrument: (a) a coupon-only version (known as an IO or Interest-only bonds); and (b) a coupon bond with principal repayment. For simplicity, we will only

[15] http://www.ssa.gov/history/lifeexpect.html

consider the first as it is a very simple instrument. The second will have a string of coupon payments and a larger principal repayment at maturity much like current bonds. Under the coupon-only version, essentially, for an upfront payment today to the issuer, the investor secures a guarantee of a fixed income from this instrument for a period of 20 years. The benefit of the coupon only version, by foregoing the principal payment, can offer higher coupons. As Figure 3 demonstrates, based on the desired income of an investor that plans to retire in 2 years, 5 years, 10 years or 30 years, and based on the implied rate of return (and therefore price of the FSB), the investor's problem of how much to save is greatly simplified. As long as there is sufficient liquidity in the instrument, the investor's decisions is now just focused on how much to save in every year of their working life to achieve this target income (given the uncertainty of interest rates). In principle, as long as the investor is not income constrained, their desired retirement income path can be hedged away at low cost. Since retirement savings take place monthly, and the price of the bond will change daily, the periodic savings decision will lead to effectively dollar-cost averaging of one's retirement annuity. In this way, the investor locks an average real return.

As more and more of these instruments are issued, the entire yield curve will be filled out much like the current yield curve plotted in Figure 3 thereby allowing individuals seeking to retire on a particular date to purchase the relevant FSB. Assuming that these instruments have sufficient credit quality, they could be very liquid – much like current nominal bonds – and will have a very transparent price and could be traded at low cost. Liquidity is critical as it allows investors to change their target retirement income with ease – namely, if one has saved too much and are projected to have to experience retirement income beyond their target, they can sell a section of their portfolio of FSBs and vice-versa. Currently, liquidating an annuity if one has over-saved is an expensive decision, and if one's health profile has

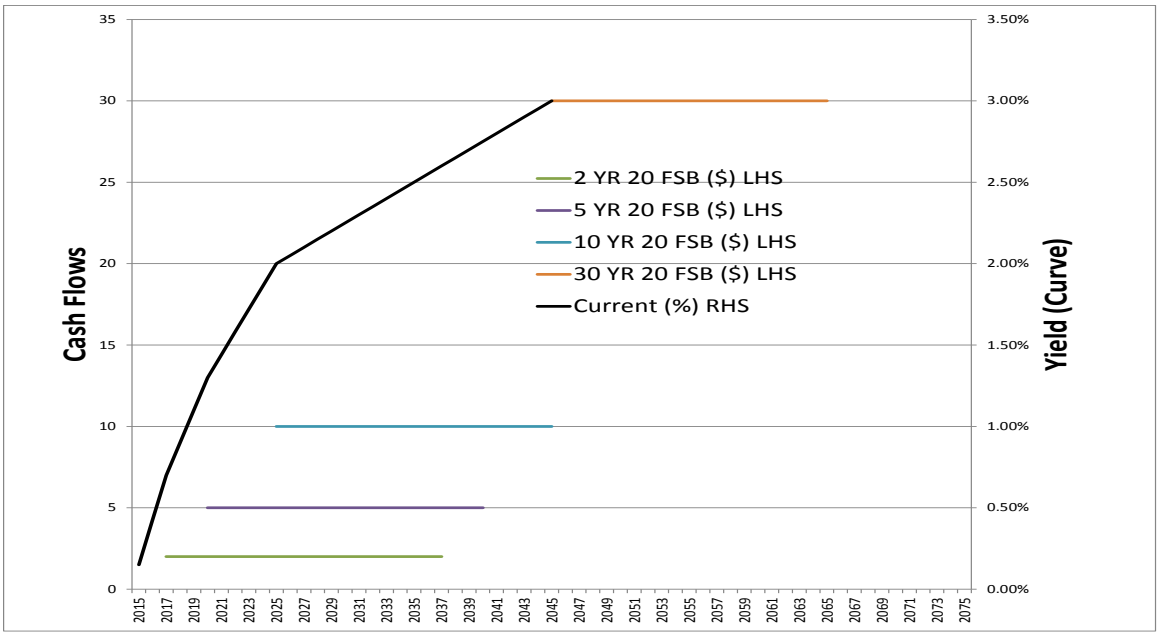
changed since their previous annuity purchase, then even access to an annuity might not be feasible, whereas one can easily purchase additional FSBs. Furthermore, those who feel like they might outlive the average life expectancy can split their savings between the bonds for their retirement date, but also for those bonds that mature on their believed date of death. This approach is much more flexible than longevity annuities being proposed (Denmark 2014b).

There is a danger that these bonds are purchased and locked away in retirement portfolios – leading to low liquidity and wide bid-ask spreads, but depending on demand and supply conditions, the yield/price on these instruments will change to reflect current market conditions. For example, bond funds that would like to take a bet on lengthening the duration of their portfolios might offer an attractive price to an investor who may consider giving up the guarantee of future income for some risk of repurchasing this instrument in the future. Moreover, these instruments might be the perfect instrument for President Obama's myRA savings vehicle as opposed to the current proposal to invest the savings of individuals in T-Bills or T-Bonds. The proponents of these programs would clearly like to offer participants an annuity, but they are currently not available among the investment options (Denmark 2014b). As can be seen from the design, rather than depending on one entity (institutional DB), or two entities (traditional DC), this simple bond can club the accumulation and decumulation in one instrument.

One of the attractive features of these bonds is that they are different from the current instruments and thereby could protect retirement savers from the intrusion of central banks into the long end of the yield curve to influence economic activity. Merton and Muralidhar (2015) note how central banks globally, in an attempt to influence growth and asset prices (i.e., to create a wealth effect), by ignoring

the relative nature of retirement investing have potentially damaged relative wealth and undermined their own efforts. For example, by depressing the yield on the traditional long bond, the US Federal Reserve sought to create wealth and stimulate investment and asset prices. However, for the typical institutional investor described in the Appendix, this decision led to an even greater increase in the Liability value, reducing the funded status of many funds and forcing companies to have to contribute more to their pension funds (thereby diverting resources away from product investments in the business), which can be seen as increasing savings and causing a savings glut, and also forcing them to reach for yield to make up the underfunding through asset growth. In a world with two different yield curves for traditional activities (e.g., mortgages, investments) and retirement activities (e.g., liabilities or retirement income), there may be less of these unintended consequences. Furthermore, it is clear that these instruments will be instrumental in hedging annuities thereby making their offering more liquid and pricing more transparent. The same would also apply to reverse mortgages as we demonstrate below.

**Figure 3: The Current US Yield Curve and Example of Coupon-Only 20 Yr FSBs**




Pricing:

*Stochastic Discount Factor Approach*

In a typical bond, assuming that we have stochastic discount factors as suggested in Cochrane and Culp (2003) - the price today for a $1 payment at some future date – also known as Arrow-Debreu prices – or zero coupon bond prices that can be estimated for the entire term of the bond, then the price of the bond is nothing more than the sum of all coupon payments multiplied by their respective discount factor. However, given that the maturity of these bonds will extend beyond the current term structure, this approach will only apply for the 10 year FSB with a maturity of 20 years.

*Market-based Pricing Approach – Demand and Supply*

However, given that the yield curve does not exist beyond 30 years, the price of the FSB will be determined by demand and supply conditions. More likely than not, this bond will have to be issued via

an auction process, whereby the market forces will determine what is the desired coupon that will make investors purchase this bond. For example, assuming that each bond has a face value of $100, the auction process will need to establish the real coupon that will be paid annually, based on a pre-agreed inflation index. The coupon will be paid annually at the start of the year for the term of the bond.

*Financial Engineering Approach*

However, because we have a TIPS yield curve up to 30 years, we can price all instruments from a 1 year FSB for 20 years all the way to a 10 year FSB for 20 years using a financial engineering approach (i.e., a no-arbitrage approach). Figure 4 shows the real cash flows that would emanate from a 10 Year FSB 20 Years and in Table 3, we create the simple 10 YR FSB 20 YRS using the current TIPS term structure in the United States. Using the financial engineering approach in Table 2, the price of the 10 YR FSB 20 YRS = long 30 TIPs + short 30 YR TIPs Zero Coupon + x(short 10 Yr) + x(long 10 Yr TIPS Zero Coupon), where x is the multiple of the 10 yr we have to purchase to make sure that x*10 yr coupon = 30 yr coupon. In other words, the cash flows of the 10 YR FSB 20 in column 7, is nothing more than sum of the cash flows of columns 3, 4, 5 and 6, and hence the price of 7 must be the equal to the sum of the prices of the bonds in columns (4) and (5), because we are long those positions, minus the sums of the prices of the bonds in columns (3) and (6), because we are short those positions. We need to use zero coupon bonds because TIPS are coupon paying bonds with (inflation-adjusted) principal repayment, and hence to create the smooth IO strip in column 7, we have to neutralize the principal repayments of the long and short position in the underlying bond.

Using this approach and the yield curve up to 30 years, we can price this bond and the 5 yr FSB 20 also, but for forward starting dates beyond 10 yrs, there is no other way to price than by running a new issue and seeing what the market will bear.

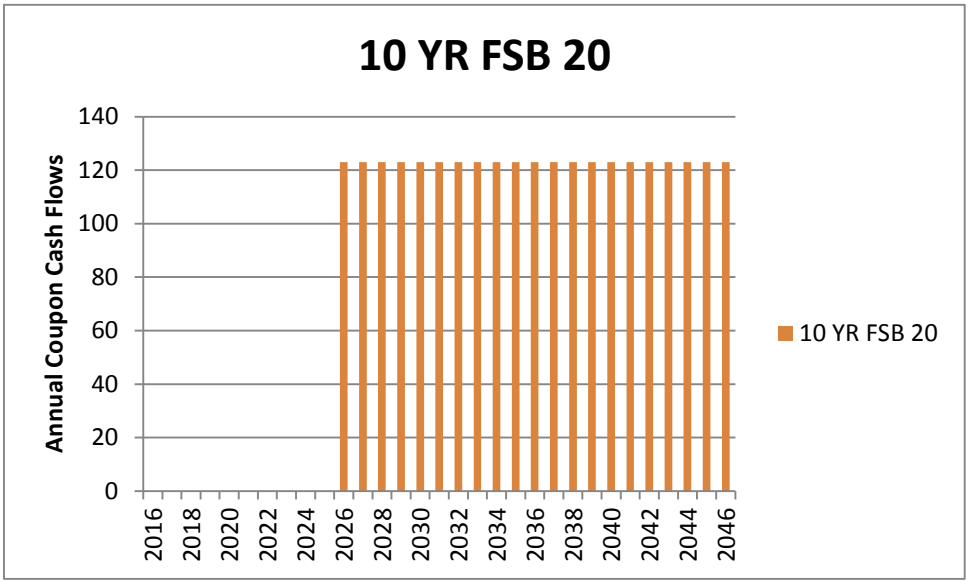



**Figure 4: A 10 YR FSB 20 Years (synthesized as in Table 3).**

| **TIPS Yield Curve (Coupon Rates** | | | | | |
|---|---|---|---|---|---|
| ***DATE*** | ***5 YR*** | ***7 YR*** | ***10 YR*** | ***20 YR*** | ***30 YR*** |
| 10/1/2015 | 0.24 | 0.42 | 0.59 | 0.99 | 1.23 |

**SYNTHETIC CREATION OF 10 YR FSB 20 YR USING CASH FLOWS OF VARIOUS BONDS**

x = 2.084745763

| **(1)** | **(2)** ***10 YR TIPs*** | **(3)** ***x(10 YR TIPS)*** | **(4)** ***30 YR TIPS*** | **(5)** ***x(10 YR ZCP)*** | **(6)** ***30 YR ZCP*** | **(7)** ***10 YR FSB 20*** |
|---|---|---|---|---|---|---|
| 2016 | 59 | -123 | 123 | | | 0 |
| 2017 | 59 | -123 | 123 | | | 0 |
| 2018 | 59 | -123 | 123 | | | 0 |
| 2019 | 59 | -123 | 123 | | | 0 |
| 2020 | 59 | -123 | 123 | | | 0 |
| 2021 | 59 | -123 | 123 | | | 0 |
| 2022 | 59 | -123 | 123 | | | 0 |
| 2023 | 59 | -123 | 123 | | | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2024 | 59 | -123 | 123 | | | 0 |
| 2025 | 10059 | -20970.46 | 123 | 20847.46 | | 0 |
| 2026 | | | 123 | | | 123 |
| 2027 | | | 123 | | | 123 |
| 2028 | | | 123 | | | 123 |
| 2029 | | | 123 | | | 123 |
| 2030 | | | 123 | | | 123 |
| 2031 | | | 123 | | | 123 |
| 2032 | | | 123 | | | 123 |
| 2033 | | | 123 | | | 123 |
| 2034 | | | 123 | | | 123 |
| 2035 | | | 123 | | | 123 |
| 2036 | | | 123 | | | 123 |
| 2037 | | | 123 | | | 123 |
| 2038 | | | 123 | | | 123 |
| 2039 | | | 123 | | | 123 |
| 2040 | | | 123 | | | 123 |
| 2041 | | | 123 | | | 123 |
| 2042 | | | 123 | | | 123 |
| 2043 | | | 123 | | | 123 |
| 2044 | | | 123 | | | 123 |
| 2045 | | | 123 | | | 123 |
| 2046 | | | 10123 | | -10000 | 123 |

**Table 2: Creating a 10 yr FSB 20 Years using 30 Year and 10 Year TIPS**

One can easily see how complex it is to financially engineer the bonds that investors desire in our simple example. In our example, a 10 Year FSB 20 Years, involves long and short positions in 4 underlying instruments, with a twist to make sure that the allocation to 10 years is coupon-adjusted based on the 30 year coupon; 2 of the bonds are market instruments (the 10 year and 30 year TIPs), and the other 2, the zero coupon bonds, have to be created synthetically by investment banks. The fact that the instrument that investors need for retirement planning is complex to create synthetically makes the case for the Treasury issuing the bond directly (as financial engineering will lead to leakage in value to end investors because of the fees to be paid to investment banks). Investment banks may feel like they are being disintermediated, but it would appear to be sensible that the Treasury issue the securities that investors desire, thereby improving the efficiency and usefulness of the market.

Duration:

The duration calculation is no different from the duration calculation of any current fixed income instrument, except that many terms in the calculation (until the forward start date) will be zero. For example, using the financial engineering approach, the duration of the 10 Yr FSB 20 Year which we engineered above = the duration of the components (long and short).

**b. Scope for Such an Instrument**

In most of the developed world, debt issuance by governments is quite substantial and many countries have debt-to-GDP ratios in excess of 100% <<need a reference>>. Moreover, in markets such as the US, there as an active corporate (and agency and supranational) bond market. In fact, Doeswijk et al (2012) note that over 54.6% of the total market for assets is in bond instruments.[16] Given the quantity of debt outstanding, there is sufficient room for some of that debt to be replaced by the FSB and hence this instrument will not infringe on other instruments, though it will make the yield curve much more complex than the current yield curve. Especially since debt instruments form a meaningful portion of retirement portfolios – both institutional and retail – replacing current bond instruments with more appropriate liability hedging instruments could lead to better LDI and lower relative risk for investors. This is clearly the case for the retail investors and for immature institutional DB and insurance portfolios;

[16] This includes government bonds, non-government bonds, inflation-linked bonds, emerging market debt and high yield debt.

the case for using FSBs in more mature DB portfolios may be low only because the duration of the pooled mix of liabilities is typically in the range of 10 -14 years, which allows for reasonable liability hedging with existing instruments.

## Section 4 – Who Will Issue FSBs?

Given the maturity and duration of this instrument, and the concerns for default and inflation risk, it would appear that the most likely issuers for this instrument (from the perspective of the investor), would be AAA-rated issuers. This potentially limits the issuance of these instruments to either governments (federal and possibly state entities) or multi-lateral agencies (e.g., IBRD, EBRD). In some rare cases, one would imagine that even corporate issuers might be able to offer these securities, and the fact that the higher credit risk of corporates could lead to an attractive yield offering for investors, could be welfare improving for the investors, especially if these instruments and liquid and traded. In fact, if one considers that insurance companies are effectively creating such individualized contracts in the form of annuities, if investors are willing to bear the risk of insurance companies, they could issue these bonds as well.

Governments (and other entities) may actually find these instruments attractive to issue because it allows them to raise debt today and defer debt service payments into the future. This is attractive to many governments because an increase in debt levels does not necessarily lead to an immediate impairment of the budget deficits. So it is easy to see why governments and other entities might want to issue these securities, especially in the current environment of impaired budgets. The danger of this

instrument, much like a 30 year (or longer dated) bond, is that it allows profligate governments to raise money from the public today and defers the obligation of being thrifty and financially solvent to future generations. This could lead to severe problems if the debt service payments for some future generations gets to be unreasonably high. In addition, these bonds could create a pecking order of default, whereby governments may choose to default first on regular bonds and lastly on these bonds as they clearly do not want to penalize their own citizens/retirees. This could raise some interesting challenges for how these instruments are treated legally and even priced. As a result, there is a strong role to be played by the rating agencies and organizations like the IMF to ensure that this instrument is not abused. However, this asset-liability management problem is one that insurance companies have dealt with for decades.

Given the magnitude of the retirement crisis globally, the issuance of such instruments to investors, in an indirect way, makes the implicit debt of retirement more explicit (Modigliani and Muralidhar 2004). In other words, when governments privatized Social Security (often at the urging of agencies like the World Bank), there was a presumption that there was no retirement liability for governments. However, Modigliani and Muralidhar (2004) had argued instead that this is a myopic view of problem as an explicit liability under the previous retirement offering was made implicit (because privatized funds with low balances would leave many with retirement incomes below the poverty levels leading to governments having to bail out poor citizens). If one could calculate the total demand for these instruments to ensure basic retirement income for all citizens, then such a measure would provide a baseline for the magnitude of a nation's retirement liability. To the extent, national retirement savings are below this level, then the gap in these two measures is the effective unfunded liability of a nation.

**Section 5: FSB Challenges**

There are many challenges even if this bond is created and issued. While it is an appealing theoretical instrument, the practical success can not be guaranteed until it is put to the litmus test of the market. Even if the conceptual argument is accepted, that such a bond would be truly useful and helpful in creating individual DBs and potentially hedging individual liabilities, there are many technical challenges to overcome.

First, is the idea of a solely coupon bond acceptable to the market? Many investors are used to traditional bonds with coupons and principal repayment, whereas this bond substitutes an upfront payment for a string of future payments with no principal repayment. However, this is a minor challenge because if this is a challenge then the issuer can consider a bond that includes principal repayment, but then the coupons are likely to be lower thereby requiring complex optimization/cash flow matching algorithms to match one's liability. However, to the extent that investors are already purchasing annuities, there is a demand for such cash flow streams. It remains an open question as to whether making it simpler, easier and cheaper to access these streams would lead to additional demand given the findings of Brown et al (2012).

Second, even if we can overcome the challenge of the type of bond, the next question is the level of demand that there would be for such an instrument and the coupon/effective price of this instrument. Since there is no instrument that extends to this maturity and with this cash flow profile, there is no basis to know what investors would require from the issuer to make this an attractive instrument. While

we can mitigate some of this uncertainty through making it a real bond and making the issuer the government entity, the required return to hold this instrument might raise the future interest cost for the governments/corporates/insurance companies to make it unattractive to the issuer (even though these are deferred payments).

Third, we have suggested that the Treasury issue this bond with different forward starting dates (e.g., 2 year, 5 year, 10 year, 20 year, 30 year etc.) and with a maturity profile that extends 20 years (or some level indexed to post-retirement life expectancy). If there is insufficient issuance at regular intervals and with an adequate term, there may be limited demand for this instrument. Hence a fair amount of research will need to be conducted into how these parameters are chosen and how these might impact an issuer in terms of its own debt service payments. Again, these parameters were suggested in this paper for convenience to lay out the basic idea but the practical issues surrounding the creation of this bond and its likely audience would make impact the final variables chosen. In effect, the issuer will need to make sure that they span the entire liability curve of the population and provide sufficient liquidity at all maturities to ensure a security that is valuable to individuals and speculators. The presence of a reasonable bid-ask spread at all maturities is what is needed to make this bond a success.

Fourth, it will be critical over time for a credit curve to evolve whereby lower credit issuers than the Treasury also issue these bonds. The benefit of having other issuers provide such bonds is critical to the success of this instrument as these bonds can offer higher yields and fill in the liquidity gaps that the Treasury might not be able to fulfil. As noted earlier, if insurance companies are already writing individual annuity contracts (which is difficult and time consuming), it would appear that a mass-marketed instrument such as an FSB bond might be appealing to them to alter their liability stream to a

more liquid, diversified portfolio. Insurance companies will offer this credit spread, and it will be easy to evaluate if the Treasury benchmark curve exists.

Fifth, is the question of what inflation-index should the bond be linked to. Some have argued that bonds should be indexed to CPI; others have argued that CPI does not protect the standard of living (Bodie, Merton and Samuelson 1992) and hence the link should be to a broader index. Again, the index to which these bonds are linked will need to be determined by a more detailed market analysis. This is very topical because Social Security has just announced that it will not offer a cost-of-living adjustment for 2016 given the low level of CPI-W. However, many retirees are arguing that that basket of consumption of retirees is different from the typical CPI-W basket and that the components of retiree consumption has experienced significantly higher inflation (Powell 2015). In an ideal world, a neutral third party will create a retiree CPI index to which such bonds should be indexed.

In summary, while the FSB might appear to be an interesting instrument to add to the panoply of financial instruments, there are many practical challenges that will need to be overcome before this becomes a successful instrument. It will be key to have sufficient issuance to ensure liquidity, all along the forward curve and with the relevant term to be appealing to investors, and ideally have reasonable pricing/bid-ask spreads combined with a credit curve to give hedgers and speculators reason enough to participate in this market.

## Section 6: Areas for Future Research

If such a bond can be created, one can imagine a number of new areas of research that can open up as a result of this innovation.

First, we assumed that these bonds have a fixed term, but in a true annuity one receives an income stream until death. Hedging longevity risk is one of the key aspects of reducing retirement income risk; there may be ways to create a hedge for individuals outliving the average life-expectancy post retirement, especially if there are bonds issued at different forward dates and potentially with different terms. We hinted at some of these earlier in the paper. More work will need to be done on this topic, but clearly, helping individuals create a complete hedge when life expectancy is unknown will be a critical area of future research.

Second, we claimed that the duality of the savings decision (how much to save and what to invest in) is now reduced to a simple decision of how much to save (because the potential income stream and average return is known). This follows because we greatly simplified the problem by assuming that many parameters (from real salary growth, desired retired income level, inflation etc.) were known. Therefore, in future research we will need to develop this paradigm to show how this instrument can greatly simplify the decision to just how much to save for a given target retirement income.

Third, we argued that this instrument can greatly help insurance companies hedge their own annuity offering. It will be critical to demonstrate how the LDI approach of either DB pension funds or insurance companies will be simplified relative to a market that only contains the current nominal bonds. The case is easier to make for insurance companies with duration extending beyond the current maximum

available in markets (e.g., 15 years); in the case of mature DB plans that can hedge their current liabilities with current instruments, adding such an instrument might not be as attractive.

Finally, we had suggested that the current reverse mortgage process is opaque and hence little used by individuals. Moreover, these instruments are typically targeted to just older individuals because of the perceived lack of hedging instruments for hedging longer term cash flow risk. Once such bonds are issued and priced, it will be interesting to show how a simple swap can be arranged with the homeowner, as the current price of the house can be mapped to a potential future cash flow stream (potentially even for young individuals as opposed to just older participants). This increased liquidity could help young investors capitalize on the equity they have in a house along with the price appreciation to lock in a future cash flow stream, while continuing to enjoy the benefits of staying in the house.

## Section 7: Conclusion

This paper sought to make the case for a new financial instrument – a Forward Starting Bond – which, if issued, could help individuals hedge retirement income risk. With a retirement crisis brewing globally and increasingly the risk being turned over to individuals who are least capable of bearing this risk with the current range of instruments and investment approaches, the introduction of this instrument might be timely. In short, if such an instrument can be created, it could allow for the creation of individual DBs.

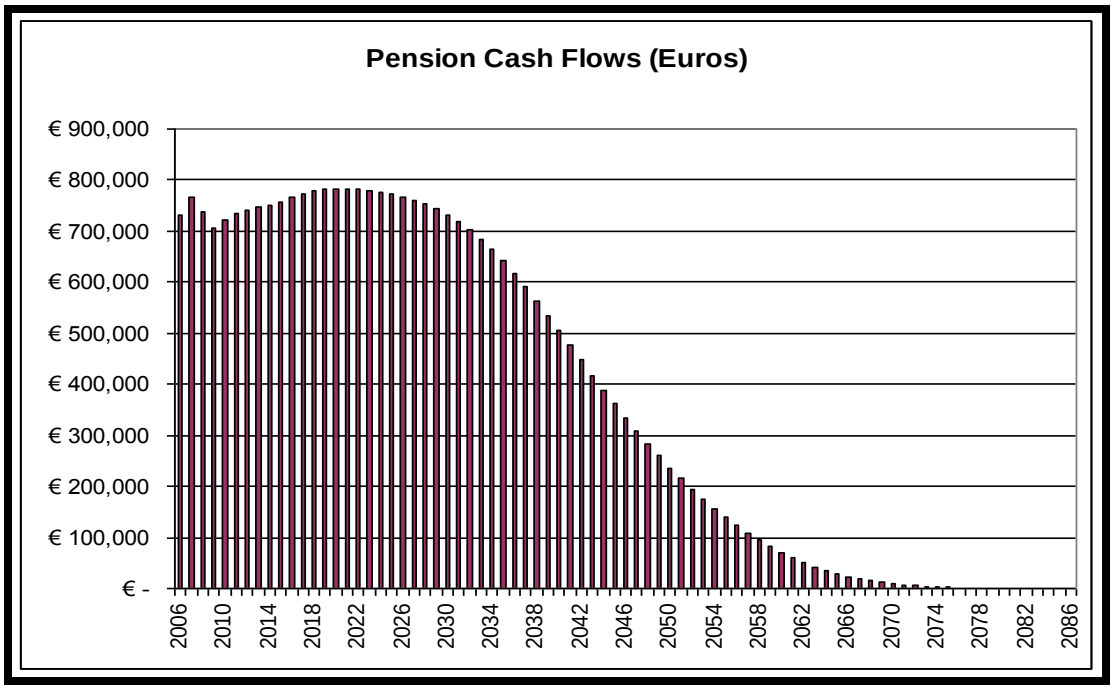
The paper examined some of the technical details around the creation of such an instrument and also discussed some of the practical challenges. It appears that such an instrument could help lower the risk, cost and complexity of achieving a target retirement income, especially if a high quality issuer like the US Treasury, can be encouraged to create this instrument. The Treasury might be the perfect candidate to create the basic instrument because of the low default risk and also that there could be some beneficial effects for budget strapped governments to push forward interest payments. It could also work for insurance companies to issue these bonds as a proxy for more customized annuities.

In summary, at least from a theoretical perspective, a FSB is an useful addition to the available instruments for retirement planning, especially since it fills such a clear role in the complex retirement process, and additional research will need to be conducted to evaluate the feasibility of the creation and issuance of such an instrument.

**Appendix: Institutional Liabilities and Asset Management Techniques**

For simplicity, we will focus just on the pension/life insurance example, but all the concepts are generic enough that we can apply them to SWFs, endowments, foundations etc. Assume every institution listed above knows its projected liability stream and is able to forecast projected future needs. In the case of a defined benefit pension fund, at its simplest, the liability is nothing more than the projected future pensions that have to be paid to every current and future employee based on their salary history, length of service, nature of the pension agreement (e.g., what accrual rate will be applied and whether indexed to inflation) and projected mortality. For a life insurance company, it is the aggregation of all cash flows from the annuities that they have promised to their clients. Figure A.1 plots the expected liability cash flows of a typical, mature, Dutch pension fund to provide some contrast between the projected liabilities of an institution vis-à-vis an individual plotted in Figure 1. If a life insurance company has diversified its client base to hedge against longevity risk, the profile might look similar. To reiterate, a liability in our definition is a stream of future cash flows, either deterministic or stochastic, in either real or nominal terms, and potentially uneven over time, the fund sponsor projects will need to be paid for the foreseeable future.

**Figure A.1. Example of a projected cash flow (liability) for a Dutch DB pension fund.**




*Source: Muralidhar (2011)*

However, in the early years of a pension fund or even an individual's life, the projected liability is large relative to accumulated assets so the funded status is less than 100 percent. This is most evident in the simple LCH model demonstrated in Figure 1 as the accumulation line gradually rises, but the projected liability of having to spend $85/year for 20 years, even in present value terms, will exceed the accumulation. In some cases, such as Social Security funds in most countries, the funding method chosen (pay-as-you-go) creates this massive imbalance (Modigliani and Muralidhar 2004). When the current pool of assets is less than the present value of projected liabilities, the fund is said to be underfunded. In a recent study of US defined benefit funds, MetLife (2012) concludes, "At the top of the importance rankings are the same two liability-related risks – Underfunding of Liabilities and Asset & Liability Mismatch – indicating that plan sponsors are more focused on the liability side of pension plan management than ever before."[17] Similarly, some organizations may over-save at the creation of the

[17] Executive Summary, MetLife (2012)

entity (e.g., foundations) and in these cases, the ratio of current assets exceeds projected liabilities and the foundation or pension fund is said to be over-funded.

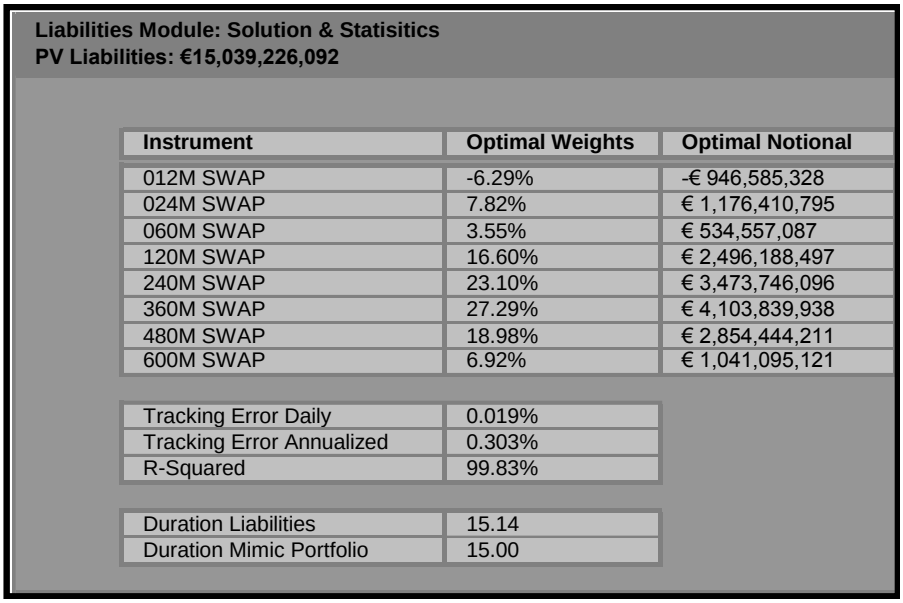
When an investor is fully funded and seeks to take no additional risk, it is possible to hedge the liability entirely. Interestingly, many pension funds globally were overfunded to a reasonable degree in the run-up to the Technology Bubble in the late 1990s, but few chose to hedge the liability and currently, the average funded status (ratio of assets to liabilities) of US corporate pension funds post the 2000-2011 period is in the mid 80% range and it is even lower for the public funds surveyed (aiCIO 2011). Also, given the rich promises made by many Social Security schemes, and the paucity of resources on hand, one could argue that nearly 90% of all institutional pension funds globally are underfunded. If an investor is underfunded, then the shortfall has to be made up either by additional savings/contributions (which Bodie, Merton and Samuelson (1992) would alternatively refer to as human capital decisions on how much to work as opposed to how much to contribute from current work habits) or by adequate investment returns, which may explain the relatively high proportion of equities and alternatives in pension portfolios (Biggs reference in Forbes xxxx).

Institutional liabilities are usually expressed as a series of cash flows into the future and this creates a conundrum for the investment team as cash flows is not the language they speak. They typically think in terms of asset classes, securities, returns, valuation of assets and volatility. As a result, step one in the investment process is a sort of translation where the investment team needs to develop a "proxy liability", expressed in asset-speak, that mimics or closely tracks the future cash outflows and allows for a frequent valuation of the sum of all cash flows (termed marking-to-market).

Assume that the liability of an individual or institution can be represented by some financial security with the usual characteristic of an expected return and volatility. When cash flows can be specified clearly as in Figure A.1, it is relatively simple to use an optimizer to select a portfolio of bonds that can mimic the projected cash flows with a high degree of tracking because bonds have predictable cash flows whereas stocks do not. Since bonds or bond derivatives constitute the liability proxy, this procedure also allows pension funds to identify a specific target duration of the proxy liability portfolio to which they benchmark their liabilities. In such cases, the performance of the liability stream can be monitored by the performance of the equivalent duration instrument as opposed to a portfolio of bonds.[18] The Dutch Central Bank has an extremely explicit method by which pension funds value pension liabilities to ensure consistency in the country (Muralidhar and van Stuijvenberg 2005) and the PME Pension Fund, in and around 2004, under the direction of Roland van den Brink, created an Investible Liability Portfolio (ILP) that then had the return and volatility characteristics of that index.[19] Subsequently, this approach was followed by many pensions. In effect, a portfolio of securities/assets is selected that matches the projected cash flows as closely as possible. Given the nature of the liability, the assets that most closely match liabilities shown in Figure A.1 are a portfolio of bonds or interest-rate swaps, with the latter approach shown in Figure A.2. However, given the limitations in the term structure of traditional bonds and swaps, this approach only works when the plan is mature and has a duration less than 20 years. In the example shown in Figure A.2, the liability duration is approximately 15.

[18] Leibowitz (1986).
[19] Van den Brink (2012).

**Figure A.2. Modeling Institutional Liabilities as a Portfolio of Swaps.**



**Liabilities Module: Solution & Statisitics**
**PV Liabilities: €15,039,226,092**

| Instrument | Optimal Weights | Optimal Notional |
|---|---|---|
| 012M SWAP | -6.29% | -€ 946,585,328 |
| 024M SWAP | 7.82% | € 1,176,410,795 |
| 060M SWAP | 3.55% | € 534,557,087 |
| 120M SWAP | 16.60% | € 2,496,188,497 |
| 240M SWAP | 23.10% | € 3,473,746,096 |
| 360M SWAP | 27.29% | € 4,103,839,938 |
| 480M SWAP | 18.98% | € 2,854,444,211 |
| 600M SWAP | 6.92% | € 1,041,095,121 |

| | |
|---|---|
| Tracking Error Daily | 0.019% |
| Tracking Error Annualized | 0.303% |
| R-Squared | 99.83% |

| | |
|---|---|
| Duration Liabilities | 15.14 |
| Duration Mimic Portfolio | 15.00 |

*Source: Muralidhar (2011)*

In the Netherlands, for many pension funds the ILP was nothing more than a portfolio of swaps; in the United States, the liability is typically represented by an index of long duration corporate grade bonds (i.e., some element of duration and credit), again with a duration of about 14 years, so there can be variation globally based on local regulation. However, the common theme is that when liabilities can be projected to some degree, typically in mature institutional portfolios, the simplest and easiest liability proxy is a portfolio of interest rate sensitive instruments – be they bonds or derivative such as swaps or futures as long as the term structure in the market extends beyond the duration of the liabilities.

What the LCH implies for investing is that essentially, if an investor is fully funded, then they can invest their asset pool in the liability security and now the return on assets is equal to the return on liabilities.

The two portfolios are perfectly correlated to one another. However, if they are underfunded, and are not willing to compromise on additional contributions or lowering future benefits (which is a reasonable assumption given current economic conditions and the general notion that benefits were guaranteed by the sponsor), then the return of assets must exceed the return of liabilities so that at some future date, the value of assets will equal or exceed the present value of liabilities – at which point, the two might be matched. The only way to generate this result is to invest in a portfolio of assets that are different from the liabilities, but now the two portfolios will not be highly correlated to each other. Many analysts applied such techniques to the Markowitz-Sharpe approach and developed "surplus management" asset-liability approaches and the most notable of these are Leibowitz (1986), Leibowitz and Henrikson (1988), Sharpe and Tint (1990), Ezra (1991) and Leibowitz, Kogelman and Bader (1992). Rather than developing an efficient frontier in asset-only space, these approaches developed an asset-liability efficient frontier.

As the last decade showed, investing in a risky portfolio different from the liability portfolio did not necessarily lead to a growth in funded status – if anything, this pattern of investing led to a deterioration in funded status globally as most investment portfolios had risky equity exposure (relative to the liabilities), which collapsed. Sadly, coincident with the decline in assets, the present value of liabilities rose as rates declined. The decade also revealed the flaws of traditional portfolio management techniques as expected return forecasts based on CAPM were badly off-target and many funds probably took more risk than they had anticipated.[20]

[20] Even prior to the 2000-2011 period, Fischer Black, after moving to Goldman Sachs and advising investors, realized how hard it was to forecast returns. Instead, the Black-Litterman (1992) approach worked backwards from an investor's actual portfolio to imply the views they had on expected returns. This model has many assumptions that practitioners do not pay enough attention to, including the choice of a risk aversion parameter, but more importantly, in imputing the implied view they assume that there is no implied volatility or correlation view. Muralidhar (2011) demonstrates why this assumption is flawed, as often a tactical directional bet implies an unintended volatility and correlation bet.

One can reasonably conclude that applying traditional MPT approaches to portfolios which are liability-based led in some part to the retirement crisis as funds took a lot of relative risk by investing in assets not highly correlated to the liabilities and did not secure the funded status when they were overfunded as MPT focuses on maximizing wealth and not minimizing the probability that funded status is less than 100 percent. Since DB funds have a residual claimant in the sponsor, there is a hope that all insurance clients and pensioners will receive the payment due to them, but in the individual DC case, the traditional portfolio techniques, with traditional instruments, make this goal very hard achieve and risky with no backstop.

**Acknowledgements**

Thanks to many individuals who helped and supported us in the development of this idea. Thanks especially to members of the CT Retirement Security Board, Robert Merton, Kathleen Kennedy, Angela Antonelli, Monte Tarbox, Jesko Hentschel, Robert Savickas, David Blitzstein, Jonathan Grabel, Ken Miranda, Chris Li, James Russell, Jon Forman, Srini Pulavarti, Mohammad Baki and the Overture Financial Team working with CA's Secure Choice Board, Frances Denmark, Roland van den Brink, Barney Buscemi……

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